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Talent Competitiveness Evaluation of the Chongqing Intelligent Industry Based on Using the Entropy TOPSIS Method

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Abstract: Talent is the foundation of industrial development, based on the movement process and the role of the talent competitiveness cycle. This study uses the Entropy TOPSIS method to evaluate the talent competitiveness of Chongqing in comparison to Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Guangdong, Sichuan, and Shaanxi from five dimensions of human resources, talent contribution, talent investment, development support, and development environment. The research shows that the talent competitiveness of the intelligent industry in Chongqing ranks eighth as compared to other eight provinces and cities. The result shows that there is a big gap in human resources, talent contribution and talent investment compared with the developed areas, while development support and environment level were found to be relatively backward. It is suggested to strengthen the policy implementation from the aspects of high-end talent introduction, investment in higher education, industrial ecological system and talent development environment.

Keywords: intelligent industry; talent competitiveness; entropy TOPSIS method

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1. Introduction

In recent years, artificial intelligence has been reshaping the global industrial landscape and becoming a key field in which countries will compete. As an inland open high-land and a national modern manufacturing base of China, Chongqing attaches great importance to the development of the intelligent industry and considers it as an important direction to achieve industrial transformation and upgrade high-quality economic development. As the main body of industrial innovation activities, talent is the foundation of industrial development in the era of knowledge economy.

In China, Chongqing is one of four municipalities directly under the Central Government, an important central city, a national historical and cultural city, an important node city in the “the Belt and Road”, an economic center in the upper reaches of the Yangtze River, an important national modern manufacturing base, and a Southwest China Comprehensive transportation hub. Under the new situation, in order to achieve high-quality economic development in Chongqing, the direction is in the intelligent industry, and the focus is on enhancing and giving play to the talent competitiveness of the intelligent industry. Therefore, the scientific evaluation of the talent competitiveness of Chongqing’s intelligent industry is helpful to find out the gap, make up the shortcoming of talent, accelerate the development of the intelligent industry, continue to improve the quality and efficiency of the development of the intelligent industry, and finally, achieve high-quality development of the regional economy. At the same time, it can also provide inspiration for the intelligent industrial development of other cities in China, and even other regions of the world.

2. Literature Review

Since IMD of Switzerland put forward the evaluation index of talent competitiveness in “The World Competitiveness Yearbook” in 2000, scholars have conducted a lot of research on talent competitiveness of countries, regions and industries. These studies mainly focus on the selection of evaluation methods and the construction of an evaluation index system. When evaluating talent competitiveness, scholars mainly establish econometric models to measure competitiveness level quantitatively. Common methods include an analytic hierarchy process, principal component analysis, fuzzy comprehensive evaluation, entropy value, coefficient of variation, BP neural network algorithm and the grey correlation degree method. In recent years, with the help of these evaluation methods, many scholars, according to their understanding of the connotations of talent competitiveness, have established an evaluation index system of talent competitiveness from multiple dimensions and studied the talent competitiveness of countries, regions and industries with a variety of methods. Among the studies of scholars, the most influential evaluation index system is the “Global Talent Competitiveness Index Report” released by INSEAD every year [1] (pp. 9–11). It mainly constructs the evaluation index system from two aspects of talent input and talent output to analyze the talent competitiveness of major countries and regions in the world. Scullion, Caligiuri, and Collings [2] constructed a talent competitiveness evaluation index system from aspects of industry, policy and environment. Anca and Marcela [3] empirically analyzed Romania’s talent competitiveness with the help of global talent competitiveness evaluation indicators. Chinese scholars have some differences in the research of talent competitiveness, and the selected evaluation dimensions and indicators are more diversified than those of foreign scholars. Liu, Xiao, and Gao [4] constructed evaluation indexes from three aspects of resources, environment and talent development, and evaluated the talent competitiveness of the Guantian Economic Zone with triangular fuzzy number network analysis. Lin and Xu [5] constructed an evaluation index system based on the sports process of competitiveness and used the AHP method to analyze the competitiveness of scientific and technological talents for Beijing, Tianjin, Shanghai and Chongqing. Zhang and Wang [6] constructed an evaluation index system based on the perspective of sustainable talent development, and comprehensively applied the AHP method and the grey correlation analysis method to measure the development level of scientific and technological innovation talents for the Hubei Province. Si, Han, and Shen [7] constructed an evaluation index system from five aspects of talent scale, structure, input, output and support, measured talent competitiveness in Shandong Province, and analyzed the correlation between talent development and economic and social development. Zhao and Yu [8] constructed an evaluation index system from the aspects of talent resources, talent efficiency, and talent environment to evaluate and compare the talent competitiveness of various provinces and cities. Liu, Chen, and Su [9] constructed an evaluation index system based on the characteristics of scientific and technological talents and performed an empirical analysis of the competitiveness of scientific and technological talents for various provinces and cities in China by PCA analysis. Wang and Qiu [10] constructed an evaluation index system from the aspects of talent quantity, efficiency, support, and environment and performed an empirical analysis of talent competitiveness in Northern Jiangsu.

Through literature review, it can be found that the current research achievements on talent competitiveness are relatively few, mainly focusing on national, regional and scientific, and technological talent competitiveness, and the research methods adopted and evaluation systems proposed are different. In general, the existing research has improved the theory of talent competitiveness to some extent, but it has not formed a unified theoretical system, and the evaluation results of industrial talent competitiveness are even rarer. Compared with the rapid development of other fields of management, the research is relatively backward. Therefore, it is necessary to introduce more effective evaluation methods and systems in combination with China’s high-quality economic development

strategy and industrial orientation to strengthen the exploration of industrial talent competitiveness.

3. Talent Competitiveness Evaluation Model

3.1. Evaluation Index System

Talent competitiveness is a comprehensive consideration of the level of human resources development which contains the essential attributes of talent attraction, talent vitality, talent strength, and talent potential. In order to consider its level and development trend, an evaluation index system of talent competitiveness can be constructed to measure it. Industry talent competitiveness is a relatively abstract concept and has a wide scope. It involves the scale, structure, and efficiency of talents owned by the industry, as well as the investment, policy, and environment that affect the development of talents in the industry. It refers to the comprehensive competitiveness of a specific industry in a country or region in terms of the quantity, quality, structure, and environment of talents. Based on the movement process and action cycle of competitiveness, combined with the research of scholars, this paper divides talent competitiveness into current competitiveness and potential competitiveness, and designs an evaluation index system of talent competitiveness of the intelligent industry from five dimensions of human resources, talent contribution, talent investment, development support, and development environment, as shown in Table 1.

Table 1. Talent competitiveness evaluation index system of the intelligent industry.

Level I	Level II	Level III	Unit	Direction	Source
Current competitiveness of talents	Human resource	Number of employees in the industry	10,000 people	+	Si et al. [7]; Liu et al. [9]; Yang et al. [11]
		Number of top talents in the industry	People	+	
		Ratio of R&D personnel in the industry to the number of employees	%	+	
	Talent contribution	Number of industrial intellectual property applications	Item	+	Liu et al. [4]; Zhao et al. [8]; Liu et al. [9]; Li et al. [12]
		Number of valid invention patents in the industry	Item	+	
		Sales revenue of new products for enterprises above industrial scale	One hundred million RMB	+	
		Industrial per capita output value	RMB 10,000	+	
		Quantity of industrial scientific and technological achievements	Item	+	
	Talent investment	Education expenditure per student in regular institutions of higher learning	RMB 10,000	+	Zhang et al. [6]; Si et al. [7]; Wang et al. [10]
		R&D investment	RMB 10,000	+	
		The proportion of general public budget expenditure in education	%	+	
		The intensity of local government investment in science and technology	%	+	
Potential competitiveness of talents	Development support	Higher education enrolment per 100,000 population	People	+	Lanvin et al. [1]; Lin et al. [5]; Bi et al. [13]; Cheng [14]; Lu et al. [15]; Zhang et al. [16]
		Number of cultural institutions	Unit	+	
		Number of high-tech enterprises	Unit	+	
		Number of institutions of higher learning	Unit	+	
		Number of research institutions	Unit	+	
	Development environment	GDP per capita	RMB 10,000	+	Lanvin et al. [1]; Liu et al. [9]; Chen [17]; Continue et al. [18]; Wei et al. [19]; Wang et al. [20]
		Average wage of employed persons	RMB 10,000	+	
		Green coverage rate in built-up areas	%	+	
		Per capita consumer expenditure	RMB 10,000	+	
		Percentage of good air quality days	%	+	
		The number of hospital beds per 10,000 people	Thousands of copies	+	

(1) Human resource

The index of the human resource dimension mainly reflects the total quantity, quality, and structure of talents owned by the intelligent industry in the region, which is the comprehensive embodiment of the human resource level of the intelligent industry. The scale of the talent is the basis to ensure the development of regional intelligent industry, and the quality of the talent is the key to enhance competitiveness. The indicators selected in this paper include number of employees in the industry, number of top talents in the industry, and the ratio of R&D personnel in the industry to the number of employees.

(2) Talent contribution

The index of the talent contribution dimension mainly reflects the contribution of industrial talents to regional economic and social development, and is a direct reflection of the achievements of industrial talents and innovation activities. The indicators selected in this paper include number of industrial intellectual property applications, number of valid invention patents in the industry, sales revenue of new products for enterprises above industrial scale, industrial per capita output value, and quantity of industrial scientific and technological achievements. Among them, the application quantity of the core intellectual property of the industry only counts the application quantity of invention patents and integrated circuit layout.

(3) Talent investment

The index of the talent investment dimension mainly reflects the comprehensive investment in talent development in a certain period, reflects the local government's emphasis on education and innovation activities, and is related to the cultivation of talent development potential. The indicators selected in this paper include education expenditure per student in regular institutions of higher learning, R&D investment, the proportion of general public budget expenditure in education, and the intensity of local government investment in science and technology.

(4) Development support

The index of the development support dimension mainly reflects the external support force in the process of attracting, selecting, developing, and retaining talents of the region, reflects the development level of local education, science and technology, and industry, and is directly related to the potential of talent development. The indicators selected in this paper include higher education enrolment per 100,000 population, the number of cultural institutions, the number of high-tech enterprises, the number of institutions of higher learning, and the number of research institutions.

(5) Development environment

The index of the development environment dimension mainly reflects the external environment construction of regional economic development, public services, and life quality. The development environment affects the work and life of talents. A high-quality development environment has become the core factor in attracting talents and the key to realizing the aggregation of talent resources, which is closely related to the development of human resource potential. The indicators selected in this paper include GDP per capita, average wage of employed persons, green coverage rate in built-up areas, per capita consumer expenditure, percentage of good air quality days, and the number of hospital beds per 10,000 people.

3.2. Evaluation Methods and Procedures

It is key to construct the evaluation model of talent competitiveness to give weight to the evaluation index of talent competitiveness. Considering that the subjective weight method is subjective and arbitrary, which brings great deviation, this paper adopts the entropy weight TOPSIS comprehensive evaluation method which has been widely used in the fields of natural science and social science to construct evaluation models [18–22]. Firstly, the entropy weight method is used to give weight to the evaluation indicators, and then the TOPSIS method is used to comprehensively evaluate the competitiveness of

talent for the intelligent industry in different regions. The specific calculation steps are as follows.

(1) Standardized data processing

It is assumed that there are i regions, j indicators, X_{ij} is the original value, Y_{ij} is the standardized value, and the original data matrix of indicators is formed:

$$X = \begin{bmatrix} X_{11} & \cdots & X_{1j} \\ \vdots & \ddots & \vdots \\ X_{i1} & \cdots & X_{ij} \end{bmatrix}$$

In order to obtain accurate evaluation results, data need to be synchemotactic and normalized, and the values of each indicator are converted into data between $[0,1]$ to eliminate dimensional influence.

Positive index processing:

$$Y_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \quad (1)$$

Negative index processing:

$$Y_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \quad (2)$$

After processing, the standardized data matrix is finally obtained:

$$Y = \begin{bmatrix} Y_{11} & \cdots & Y_{1j} \\ \vdots & \ddots & \vdots \\ Y_{i1} & \cdots & Y_{ij} \end{bmatrix}$$

(2) Calculate the proportion of each index

$$P_{ij} = Y_{ij} / \sum_{i=1}^m Y_{ij} \quad (3)$$

(3) Calculate the information entropy of each index

$$E_j = -\frac{1}{\ln m} \sum_{i=1}^m P_{ij} \ln P_{ij} \quad (4)$$

Among them, when $P_{ij} = 0$, the value of $0 \ln 0$ is 0.

(4) Calculate the weight of each index

$$W_j = \frac{1 - E_j}{m - \sum_{j=1}^m E_j} \quad (5)$$

Among them, W_j is the range of $[0,1]$, $j = 1, 2, \dots, m$.

(5) Construct weighted normalization matrix

$$Z = \begin{bmatrix} Y_{11} \cdot W_1 & Y_{12} \cdot W_2 & \cdots & Y_{1j} \cdot W_j \\ Y_{21} \cdot W_1 & Y_{22} \cdot W_2 & \cdots & Y_{2j} \cdot W_j \\ \vdots & \vdots & \ddots & \vdots \\ Y_{i1} \cdot W_1 & Y_{i2} \cdot W_2 & \cdots & Y_{ij} \cdot W_j \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} & \cdots & Z_{1j} \\ Z_{21} & Z_{22} & \cdots & Z_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ Z_{i1} & Z_{i2} & \cdots & Z_{ij} \end{bmatrix}$$

Among them, $Z_{ij} = Y_{ij} \cdot W_j$.

(6) Determine the optimal and the worst scheme according to the weighted normalization matrix

$$Z^+ = (\max Z_{i1}, \max Z_{i2}, \dots, \max Z_{ij}) \quad (6)$$

$$Z^- = (\min Z_{i1}, \min Z_{i2}, \dots, \min Z_{ij}) \quad (7)$$

In the above formula, Z^+ is the optimal solution (positive ideal solution) and Z^- is the worst solution (negative ideal solution).

(7) Calculate the distance D^+ and D^- between each evaluation object and the positive and negative ideal solutions

$$D_i^+ = \sqrt{\sum_j (\max Z_{ij} - Z_{ij})^2} \quad (8)$$

$$D_i^- = \sqrt{\sum_j (Z_{ij} - \min Z_{ij})^2} \quad (9)$$

(8) Calculate the closeness degree between the evaluation object and the optimal program (i.e., talent competitiveness index)

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (10)$$

Among them, the C_i value range is [0,1]. C_i value reflects the degree of competitiveness of talent in the intelligent industry in the region, and the larger the value, the stronger it is.

(9) Comprehensive evaluation of competitiveness level

According to the relationship between the talent competitiveness index value C_i , the average value (substituted by letter V), and the standard deviation (substituted by letter σ), the talent competitiveness level of the intelligent industry in each province and city can be divided into three levels, as shown in Table 2.

Table 2. Standard of talent competitiveness level in intelligent industry.

Competitiveness Index	$V + 0.5\sigma < C_i$	$V - 0.5\sigma \leq C_i \leq V + 0.5\sigma$	$C_i < V - 0.5\sigma$
Level of competitiveness	The first echelon	The second echelon	The third echelon

4. Results and Discussion

4.1. Data Sources

Considering the availability of the evaluation index data and the comparability of the comparison samples, this paper selected eight provinces and cities (Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang, Guangdong, Sichuan, and Shaanxi) to make a comparison with Chongqing. The choice of Beijing, Shanghai, Jiangsu, Zhejiang, and Guangdong is because these provinces and cities are all developed areas of intelligent industry in China. Through comparison, we can know the gap existing in Chongqing and the direction of its efforts better. Tianjin, Sichuan, and Shaanxi are selected because they have the same industrial development level as Chongqing, and there has always been a competitive and cooperative relationship between them. Understanding the competitors is conducive to adopting a misplaced competition strategy.

Among the 23 evaluation indicators identified, the data of most of them can be obtained directly, while a few of them need to be converted. The specific sources of the index data are shown in Table 3.

Table 3. Data sources of evaluation indicators.

The Evaluation Index	The Data Source
Number of employees in the industry	China Population and Employment Statistical Yearbook, China High-tech Industry Statistical Yearbook
Number of top talents in the industry	Tsinghua University Aminer Platform
Ratio of R&D personnel in the industry to the number of employees	China Population and Employment Statistical Yearbook, China High-tech Industry Statistical Yearbook, China Science and Technology Statistical Yearbook
Industry core intellectual property application volume	China High-tech Industry Statistical Yearbook, State Intellectual Property Office
Number of valid invention patents in the industry	China High-tech Industry Statistical Yearbook, State Intellectual Property Office
Sales revenue of new products for enterprises above industrial scale	China High-tech Industry Statistical Yearbook, China Science and Technology Statistical Yearbook
Industrial per capita output value	China Population and Employment Statistical Yearbook, China High-tech Industry Statistical Yearbook, China Science and Technology Statistical Yearbook
Quantity of industrial scientific and technological achievements	National Science and Technology Achievements Network
Education expenditure per student in regular institutions of higher learning	China Science and Technology Statistical Yearbook
R&D investment	China Statistical Yearbook
The proportion of general public budget expenditure in education	Announcement on Statistics on the Implementation of National Education Funds
The intensity of local government investment in science and technology	National Statistical Bulletin on Science and Technology Investment
Higher education enrolment per 100,000 population	China Statistical Yearbook
Number of cultural institutions	China Statistical Yearbook
Number of high-tech enterprises	China Science and Technology Statistical Yearbook
Number of institutions of higher learning	China Statistical Yearbook
Number of Research Institutions	China Science and Technology Statistical Yearbook
GDP per capita	China Statistical Yearbook
Average wage of employed persons	China Statistical Yearbook
Green coverage rate in built-up areas	China Statistical Yearbook
Per capita consumer expenditure	China Statistical Yearbook
Percentage of good air quality days	Bulletin on the State of China's Ecology and Environment
The number of hospital beds per 10,000 people	China Statistical Yearbook

Since the concept of “artificial intelligence” was first proposed at the Dartmouth Conference in 1956, the development of artificial intelligence has experienced ups and downs several times, but there is no consensus on the definition of artificial intelligence. The intelligent industry studied in this paper is a wide intelligent industry, which belongs to the high-end field of the manufacturing industry and is a typical emerging industry. It covers more than the artificial intelligence industry, including not only the industries with artificial intelligence, the Internet, and big data technology as the output, but also the industries with product design and manufacturing based on relevant technologies. In view of the wide coverage of the intelligent industry, various provinces and cities differ regarding its definition and statistical caliber; for ease of horizontal comparison, this paper, involving intelligence industry data, unified software and information services, computer and office equipment manufacturing, electronic and communication equipment manufacturing, and instrumentation manufacturing summary data, instead of the four main industries.

4.2. Empirical Measurement

4.2.1. Empowerment of the Talent Competitiveness Evaluation Index in the Intelligent Industry

Based on the data of nine provinces and cities in 2018, the entropy weight method is used to give objective weight to the evaluation index of talent competitiveness in the intelligent industry constructed above. Firstly, the original data of the evaluation indicators are standardized with the help of Equations (1) and (2), and then the information entropy and weight of each evaluation indicator are calculated with the help of Equations (3)–(5). The calculated results are shown in Table 4.

Table 4. Talent competitiveness evaluation index weight of the intelligent industry.

The Dimension	The Weight	Specific Indicators	Entropy	The Weight	The Total Weight
Human resource	0.1505	Number of employees in the industry	0.6779	0.3948	0.0594
		Number of top talents in the industry	0.6682	0.4062	0.0612
		Ratio of R&D personnel in the industry to the number of employees	0.8374	0.1990	0.0300
Talent contribution	0.3069	Industry core intellectual property application volume	0.5555	0.2670	0.0820
		Number of valid invention patents in the industry	0.4756	0.3151	0.0967
		Sales revenue of new products for enterprises above industrial scale	0.6121	0.2330	0.0715
		Industrial per capita output value	0.7972	0.1218	0.0374
		Quantity of industrial scientific and technological achievements	0.8950	0.0631	0.0194
Talent investment	0.1510	Education expenditure per student in regular institutions of higher learning	0.6884	0.3804	0.0574
		R&D investment	0.7945	0.2509	0.0379
		The proportion of general public budget expenditure in education	0.9259	0.0905	0.0137
		The intensity of local government investment in science and technology	0.7721	0.2782	0.0420
Development support	0.2274	Higher education enrolment per 100,000 population	0.7968	0.1648	0.0375
		Number of cultural institutions	0.6464	0.2867	0.0652
		Number of high-tech enterprises	0.6464	0.2867	0.0652
		Number of institutions of higher learning	0.8344	0.1343	0.0305
		Number of research institutions	0.8427	0.1275	0.0290
Development environment	0.1642	GDP per capita	0.8801	0.1346	0.0221
		Average wage of employed persons	0.7851	0.2413	0.0396
		Green coverage rate in built-up areas	0.8796	0.1352	0.0222
		Per capita consumer expenditure	0.8374	0.1827	0.0300
		Percentage of good air quality days	0.8794	0.1354	0.0222
		The number of hospital beds per 10,000 people	0.8479	0.1708	0.0280

4.2.2. Comprehensive Competitiveness Level Measurement of Intelligent Industry Talent

The TOPSIS method was used to measure the comprehensive competitiveness index of intelligent industry talent in nine provinces and cities in 2018. According to Equations (6)–(10), the proximity to positive and negative ideal solutions and the comprehensive competitiveness index of intelligent industry talent in nine provinces and cities were calculated, and the ranking and mathematical analysis of the results were conducted. The results were shown in Tables 5 and 6.

Table 5. Comprehensive evaluation results of talent competitiveness in the intelligent industry in nine provinces and cities in 2018.

Provinces and Cities	D+	D−	Comprehensive Competitiveness Index	Rank
Beijing	0.176	0.127	0.420	2
Tianjin	0.214	0.056	0.206	6
Shanghai	0.191	0.077	0.288	4
Jiangsu	0.163	0.093	0.362	3
Zhejiang	0.190	0.066	0.256	5
Guangdong	0.091	0.198	0.685	1
Chongqing	0.220	0.047	0.174	8
Sichuan	0.212	0.048	0.184	7
Shaanxi	0.219	0.034	0.136	9

Table 6. Comprehensive index analysis of talent competitiveness of the intelligent industry in nine provinces and cities.

Sample Size	Min	Max	Average	S.D.	Median
9	0.136	0.685	0.301	0.171	0.256

As can be seen from Tables 5 and 6, the comprehensive score of the talent competitiveness index of the intelligent industry in nine provinces and cities is distributed between 0.136 and 0.685, with an average of 0.301 and a standard deviation of 0.171. According to the index value of talent competitiveness and the standard of talent competitiveness, nine provinces and cities can be divided into three echelons.

The talent competitiveness index score of the intelligent industry in the first echelon provinces and cities is higher than 0.3865, including for Guangdong and Beijing, which score 0.685 and 0.420, respectively. These two provinces and cities have the highest level of human resource development in the intelligent industry, scoring ahead of other provinces and cities and having the best comprehensive performance.

The talent competitiveness index score of the intelligent industry in the second echelon provinces and cities is 0.2155–0.3865, including the three provinces and cities of Jiangsu, Shanghai, and Zhejiang, whose scores are 0.362, 0.288, and 0.256, respectively. The level of human resource development of the intelligent industry in these three provinces and cities is relatively high, but there is still room for improvement.

The talent competitiveness index score of intelligent industry of the third echelon provinces and cities was lower than 0.2155, including Tianjin, Sichuan, Chongqing, and Shaanxi, whose scores were 0.206, 0.184, 0.174, and 0.136, respectively. The level of human resource development of the intelligent industry of these four provinces and cities was relatively low, which was significantly different from that of developed areas, and there was a large room for improvement. The lower three provinces and cities are all in the western region, indicating that there are obvious regional differences.

4.2.3. Dimension Measurement of Talent Competitiveness in the Intelligent Industry

In order to compare the talent competitiveness of different dimensions of the intelligent industry in different provinces and cities, the TOPSIS method is used to measure the talent competitiveness of different dimensions. According to Formulas (6)–(10), the scores

of different dimensions of talent competitiveness in the intelligent industry in each province and city were calculated, and the ranking and mathematical analysis of the results were conducted. The results are shown in Tables 7 and 8.

Table 7. Evaluation results of the talent competitiveness index of the intelligent industry.

Provinces and Cities	Human Resource		Talent Contribution		Talent Investment		Development Support		Development Environment	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Beijing	0.583	2	0.122	6	0.825	1	0.349	3	0.641	1
Tianjin	0.189	7	0.196	4	0.152	6	0.185	6	0.360	7
Shanghai	0.248	5	0.117	7	0.504	2	0.161	8	0.619	2
Jiangsu	0.323	3	0.239	2	0.385	4	0.527	2	0.435	5
Zhejiang	0.293	4	0.158	5	0.279	5	0.276	4	0.450	4
Guangdong	0.684	1	0.792	1	0.463	3	0.712	1	0.499	3
Chongqing	0.019	9	0.206	3	0.092	9	0.089	9	0.309	8
Sichuan	0.130	8	0.109	8	0.111	8	0.193	5	0.397	6
Shaanxi	0.194	6	0.069	9	0.124	7	0.168	7	0.175	9

Table 8. Index analysis of talent competitiveness of the intelligent industry in nine provinces and cities.

Indicators Dimension	Min	Max	Average	S.D.	Median
Talent resources	0.019	0.684	0.296	0.213	0.248
Talent contribution	0.069	0.792	0.223	0.220	0.158
Talent investment	0.092	0.825	0.326	0.244	0.279
Development support	0.089	0.712	0.296	0.203	0.193
Development environment	0.175	0.641	0.432	0.146	0.435

(1) Human resource dimension

It can be seen from Tables 7 and 8 that the talent competitiveness score of the intelligent industry in the human resources dimension of the nine provinces and cities ranges from 0.019 to 0.684, with a mean score of 0.296 and a standard deviation of 0.213. Among the nine provinces and cities, Guangdong has the highest score, while Chongqing has the lowest score. The former's score is 36.00 times that of the latter, indicating that there is a great difference in the quantity and quality of talent resources among different provinces and cities. Three provinces, Guangdong, Beijing, and Jiangsu, scored higher than average, indicating that the quantity and quality of existing human resources in the intelligent industry in these provinces are high.

(2) Dimension of talent contribution

It can be seen from Tables 7 and 8 that the talent competitiveness scores of the intelligent industry in the talent contribution dimension of the nine provinces and cities are distributed between 0.069 and 0.792, with a mean score of 0.223 and a standard deviation of 0.220. The highest score of the nine provinces and cities is Guangdong, and the lowest score is Shaanxi, the former's is 11.48 times that of the latter. Moreover, the scores of Guangdong and Jiangsu are higher than the average, which indicates that the contribution level of industrial talents to regional economic and social development varies greatly among different provinces and cities, and the innovation activities of the intelligent industry in most provinces and cities are not rich.

(3) Dimension of talent investment

It can be seen from Tables 7 and 8 that the scores of talent competitiveness of the intelligent industry in nine provinces and cities are distributed between 0.092 and 0.825, with an average score of 0.326 and a standard deviation of 0.244. Among the nine provinces and cities, Beijing scored the highest, while Chongqing scored the lowest, which was 8.97 times higher than the latter. The scores of Beijing, Shanghai, Guangdong, and Jiangsu are higher than the average. These provinces and cities are economically developed areas. The local government pays more attention to education and innovation activities, and the comprehensive investment in talent development is relatively high.

(4) Development support dimension

It can be seen from Tables 7 and 8 that the talent competitiveness score of the intelligent industry in the talent development support dimension of the nine provinces and cities is distributed between 0.089 and 0.641, with the mean score of 0.296 and a standard deviation of 0.203. Of the nine provinces and cities, Guangdong scored the highest, while Chongqing scored the lowest. The former's score was 7.20 times higher than the latter. The scores of Guangdong, Jiangsu, and Beijing are higher than the average. The development level of industry, science and technology, and education in these provinces and cities is relatively high, which can play a strong supporting role in the process of attracting, selecting, developing, and retaining talent in the intelligent industry.

(5) Development environment dimension

It can be seen from Tables 7 and 8 that the scores of talent competitiveness of the intelligent industry of nine provinces and cities in the dimension of talent development environment range from 0.175 to 0.684, with an average score of 0.432 and a standard deviation of 0.146. The highest score of nine provinces and cities is Beijing, and the lowest score is Shaanxi, the former's score is 3.91 times of the latter. The talent development environment dimension scoring average in talent competitiveness scored highest in five dimensions, and, in addition to the Shaanxi province score, was higher than 0.3, explaining that most of the provinces and cities attach great importance to the development of the environmental influence on human resource development potential, and the differences in economic development, public service and quality of life are small.

5. Conclusions

In order to directly analyze the talent competitiveness of the intelligent industry in Chongqing, the data in Tables 5–8 are drawn into a radar chart (Figure 1). As can be seen from Figure 1 and the above data, the comprehensive score of talent competitiveness in the intelligent industry in Chongqing ranks eighth, and the scores of the five evaluation dimensions are all lower than their respective mean values, while the scores of the talent contribution dimension are close to the mean values. Among the five evaluation dimensions, the score of the talent contribution dimension ranks third, and the relatively high ranking of this dimension is mainly due to the good performance of the index of the industry per capita output value. The score of the development environment dimension ranked eighth, and the performance of most indicators of this dimension was weak. Only the green coverage rate of built-up areas and the proportion of days with good air quality performed well. The scores of the human resource dimension, human resource investment dimension, and development support dimension all ranked last place. Most of the indicators of these three dimensions performed poorly, especially the number of top talent in the industry, the proportion of the number of R&D people in the industry, the proportion of the number of employees in the industry, the educational expenditure per student in ordinary colleges and universities, the number of research institutions, and other indicators. Through the analysis, it can be seen that the level of human resource development of the intelligent industry in Chongqing is relatively backward, and there is a big gap between its talent competitiveness and that of developed areas. In order to make up for the shortcoming of talent, it is urgent to strengthen policy implementation in the introduction of high-end talents and invest in higher education, industrial ecological systems, talent development environments, and other aspects.

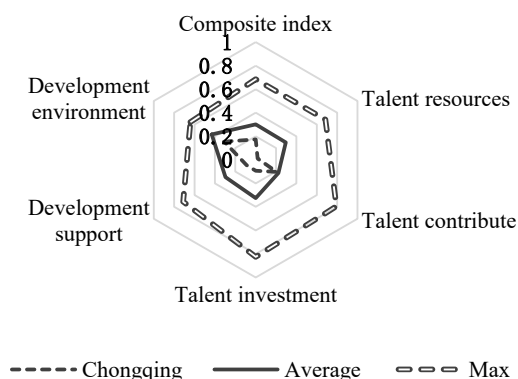


Figure 1. Radar chart of talent competitiveness index of the intelligent industry in Chongqing.

6. Suggestions and Enlightenment

6.1. Strive to Consolidate the Team of High-End Talents in the Intelligent Industry

High-end talents are the key factor to determining the high-quality development of the industry. Chongqing should strengthen the high-level talent team according to the development needs of the intelligent industry. One is to rely on high-level overseas talent converging projects, increase the intensity of overseas conferences, a chance to traction the industry's top talents to visiting professors, research, consulting, and technical guidance in exchanges and cooperation, and synchronous improvement of housing, health care, social insurance, child education, and employment security of family members, solving the troubles at home of high-end talent. Second, by relying on key enterprises, major projects, and demonstration projects in the intelligent industry, we will improve the income of individuals and teams by means of equity incentives and industry guide funds, so as to attract industry-leading talent and innovation teams to start businesses in Chongqing and enhance the innovation power of the industry [23]. Third, integrating all kinds of resources to establish talent training bases for the intelligent industry, actively carrying out special training for talent in short supply, establishing a professional talent training system of wide and multi-level fields, promoting the transformation of mid-end talent to high-end talent through all kinds of training, and continuously optimizing the talent structure of the industry.

6.2. Increase Investment in Higher Education and Vocational Education

General higher education and vocational education are an important method of transforming "population" into "talent", and are also the main channel of intelligent talent training and human capital investment by the government. The government should fully understand the important role of higher education and vocational education in industrial talent development and increase investment in higher education and vocational education. First, we will clarify the educational responsibilities of governments at all levels, properly arrange their fiscal expenditures, give priority to ensuring education input, and increase the total appropriations of governments at all levels for higher education and vocational education year by year, so as to catch up with and exceed the national average level as soon as possible. Second, we will increase funding for the performance of talent in higher education and vocational education, dynamically adjust the proportion of funding for performance according to the annual performance evaluation of talent output, and constantly improve the efficiency of talent output in higher education and vocational education. Third, we will implement a tax reduction policy for the service income of colleges and universities and use the reduced and exempted funds to support investment in personnel training, teacher training, student employment and scientific research of colleges

and universities [24]. Fourth, we will increase financial support for the areas with poor resources for higher education and vocational education, and improve the level of personnel training in backward areas.

6.3. Promote the Construction of an Industrial Talent Training Ecosystem

The industrial talent ecosystem plays an important role in stimulating talent potential and realizing talent value, which directly determines the talent attraction and carrying capacity of an industry. The government should accelerate the construction of the talent training ecosystem for the intelligent industry, and enhance the gathering power of “high-level, sophisticated and excellent” talent. First, in combination with the actual needs of industrial development, they should accelerate the integration of production, education, and research, promote the coordinated advancement of industries, organizations and talents, form an integrated development model of “industry + platform + talent”, and build an underlying guarantee of the ecological system. Second, to build an industry talent exchange platform, with the help of the platform to focus on the common problems of talent work, they should carry out a discussion and experience exchange, and from the industry level to regulate the flow of talent order, to prevent malicious recruitment, advocate intelligent industry enterprises to reasonably and fairly attract talents and respect and care for talents to provide sustainable power for the ecosystem. Third, an industry think tank should be established to strengthen regular contact with talent at all levels of the industry, grasp the development trend of talent in real time, study the difficulties and hot issues existing in the ecological environment of talent in the industry, and put forward targeted suggestions on talent work from the perspective of the industry to support the healthy development of the ecological system.

6.4. Improve the Social and Cultural Environment for Talent Development

Environment is an important factor affecting the potential competitiveness of talent in the intelligent industry. The government should optimize and improve the external environment of the region, create a good social atmosphere conducive to the growth of talents, give talent the opportunity to give full play to their talents, and promote the sustainable performance of talent. First, we need to improve the capacity of public services and create an appropriate working and living environment. We should put sustainable development in a prominent position, constantly improve the living environment of human beings, continuously improve the level of medical care, advocate green production and healthy lifestyles, enhance the sustainable development ability of cities and talents by improving the working and living environment of talent, and achieve the purpose of attracting and retaining talent. The second requirement is to enhance the city’s cultural soft power by promoting local characteristic culture, relying on the local human geography and intangible cultural heritage, creating cultural highlights, boosting the spirit of the entire society, and giving play to the emotional attraction of culture to talent. Third, we should create a harmonious and transparent environment for fair competition, eliminate all kinds of institutional discrimination in human resources, improve the labor dispute settlement mechanism and social security system, improve the economic treatment and social status of talents, and stimulate the creativity of talents.

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